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REMARKS

Summary

By this Amendment, Claims 4, 13 and 14 have been revised, and new dependent Claims 18 and 19 have been added.

Accordingly, Claims 4, 6-10 and 13-19 are now pending in the application.

35 U.S.C. §102 – Lee et al.

Claims 4, 13 and 14 were rejected under 35 U.S.C. §102 as being anticipated by Lee et al. (US 5,843,843) for the reasons stated at pages 2 and 5 of the Office Action. Applicants respectfully traverse this rejection with respect to the now-pending claims.

At page 5 of the Office Action, the Examiner states:

“Applicant has not stated what conditions are different between the instant process and Lee et al. such that the results of the x-ray diffraction peak half width on a crystallographic plane of the deposited metallic layer is narrowed would be obtained.

Note in Col. 19, lines 62-66, that the grain size changed which would alter the x-ray diffraction peak.”

Contrary to the Examiner’s statement, Applicant’s explained in their previous response that the process of Lee et al. is a gentle treatment (low power and short treatment time), whereas the treatments of the present embodiments are conducted at much higher powers to narrow the x-ray diffraction peak half width on a crystallographic plane of the deposited metallic layer. To further clarify this distinction of the invention, claim 4 has been revised to recite that the “duration and plasma power of the hydrogen treatment are ... such that the x-ray diffraction peak half width on a crystallographic plane of the deposited metallic layer is narrowed.” Applicants submit it to be manifest that Lee et al. does not teach or suggest this limitation of claim 4.

Further, claims 4, 13 and 14 have been revised to clarify that the enhancement of the crystallographic structure is relative to a layer deposited without the hydrogen treatment of the present invention. Again, Applicants submit it to be manifest that Lee et al. does not teach or suggest this aspect of claims 4, 13 and 14.

Lee et al. simply terminates dangling oxygen bonds and does not remove any oxides on the diffusion barrier layer. He does this to increase the mobility of the metal layer and/or the wettability between the barrier layer and the metal layer. At the bottom of column 19 Lee suggests that if these dangling bonds are terminated then the metal layer will have larger grains. This may well be right because in terminating the dangling bonds, he is removing nucleation sites, which would generally create the initial growing points for the grains and so the outcome of larger grains is quite likely. In effect, his process is analogous to greasing the surface, which is why the metal mobility and indeed the wettability is increased. However, larger grains do not mean increased orientation. Rather, the reverse seems to be true from Figures 12 and 14 of Lee where the larger grains are irregular and do not appear to pack well.

For *at least* the reasons stated above, Applicants respectfully contend that Claims 4, 13 and 14 define over the teachings of Lee et al.

35 U.S.C. ¶103 – Lee et al. in view of Ameen et al.

Claims 6, 7 and 8 were rejected under 35 U.S.C. ¶103 as being obvious over Lee et al. (US 5,843,843) in view of Ameen et al. (US 6143128) for the reasons stated at page 3 of the Office Action. Applicants respectfully traverse this rejection with respect to the now-pending claims.

In the Office Action, the Examiner states:

“Lee et al. does not disclose that the plasma is Inductively Coupled Plasma, and that the substrate is placed on a RF biased platen, which is heated.

Ameen et al. disclose hydrogen plasma formed by a coupled RF energy wherein the plasma can be an Inductively Coupled Plasma and the wafer is supported on a heated platen

It would have been obvious ... to combine the teachings of Lee et al. and Ameen et al. to enable formation of the treated surface of Lee et al.”

Respectfully, the Examiner seems to have overlooked the objective and teachings of Lee et al. The Lee arrangement as a “soft” treatment and is based on a remote source – the electron cyclotron resonance source – and specifically this does not require either heating of the substrate or applying bias to the substrate (see lines 67 at the bottom of column 10 and line 1 of column 11). At lines 1-17 Lee explains why the use of a bias, such as in RF etching, is undesirable. In the succeeding paragraph he makes it clear that one should carry out a gentle process which simply terminates dangling oxygen bonds and does not remove any oxides on the diffusion barrier layer. He does this to increase the mobility of the metal layer and/or the wet ability between the barrier layer and the metal layer. It will be noted in the examples that the hydrogen treatment last for between ten seconds and one minute and is performed at essentially ambient temperature.

One of ordinary skill would not modify Lee et al. in the fashion suggested by the Examiner, and in fact, Lee et al. expressly teaches away from such modification.

For *at least* the reasons stated above, Applicants respectfully contend that Claims 6, 7 and 8 define over the teachings of Lee et al. and Ameen et al.

35 U.S.C. ¶103 – Lee et al. in view of Kondo et al.

Claims 9 and 10 were rejected under 35 U.S.C. §103 as being obvious over Lee et al. (US 5,843,843) in view of Kondo et al. (US 6001736) for the reasons stated at pages 3-4 of the Office Action. Applicants respectfully traverse this rejection with respect to the now-pending claims.

Applicants essentially traverse this rejection for the same reasons as stated above regarding Claims 6, 7 and 8. Lee et al. expressly teaches away from a high-energy and etch-like hydrogen treatment, and one of ordinary skill in the art would not adopt the RIE plasma treatment of Kondo et al. in the process of Lee et al.

35 U.S.C. §103 – Lee et al. in view of Roy et al.

Claims 15-17 were rejected under 35 U.S.C. §103 as being obvious over Lee et al. (US 5,843,843) in view of Roy et al. (US 6025762) for the reasons stated at page 4 of the Office Action. Applicants respectfully traverse this rejection for the same reasons as discussed above in connection with Claims 4, 13 and 14.

Conclusion

No other issues remaining, reconsideration and favorable action upon the Claims 4, 6-10 and 13-19 now-pending in the application are requested.

Respectfully submitted,

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